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Characterization and Water Productivity of Irrigated Farms At Project Site Fateh Jang: A Case Study

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Abstract

This study was conducted to evaluate the achievable ranges of water productivity for wheat, sorghum, maize, turnip, radish and methi of irrigated farms around project site in tehsil Fatehjang of Punjab-Pakistan. The results of the study show that agriculture and livestock played an imperative role as a main source of income of the respondents. The major crops grown in rabi and kharif on small and large scale were wheat, maize, sorghum, chilies, radish, turnip, onion, cucumber etc. It was assessed that water productivity at the field of farmers were low and this was due to over irrigation and no proper idea of exact irrigation timing and knowledge about high efficiency irrigation system. The average yields for wheat, sorghum, maize, turnip, radish and methi were found to be 2,832, 277, 1888, 18476, 18226 and 3359 kg/ha respectively. Whereas the average water productivities were 0.46, 0.22, 0.31, 1.91, 1.88 and 0.34 kg/m^3 respectively. The comparative analysis of the water productivity indicates that sorghum has the lowest water productivity followed by the maize and methi while turnip has the highest water productivity followed by the radish and wheat. There is enormous gap in water productivity of most crops between the highest and the lowest productive farmers. Hence, there is an immense capacity to increase the water productivity by adopting proper parameter of water and non-water inputs up to assured levels without compromising on the yield.

Keywords: Resource characterization, water productivity, crops yield.

Introduction

The world is facing an impending water shortage that will obscure national and global efforts to alleviate and halt food shortages in many regions. Pakistan's economy greatly relies on the productivity of the agriculture sector and irrigation remains drastically important as a mean to enhance production and increase water use efficiency. Hence there is a large potential to get better water productivity through improved and known water management practices. USAID observed that Pakistan is facing severe water stress and its surface and groundwater sources are at their limit. Like other most arid countries, Pakistan has also the world's largest adjacent irrigated area in the shape of the Indus Basin Irrigation System. The country's once vast groundwater assets are exposed by Stalinization and water logging due to rigorous irrigation[1]. Government of Pakistan affirmed that the per capita water availability has reduced from 5600 m^3 to about 1200 m^3 from 1951 to 2003 and it will further reduce to about 1000 m^3 by the year 2010. The present overall shortfall of 11% will increase to 31% by the year 2025[2]. Cai and Rosegrant analyzed that irrigated agriculture is the prime user of freshwater resources in the world and around 69% of the freshwater and 56% of the world irrigated area is in Asia[3]. Molden et al examined that water is one of the most vital inputs to agriculture and food security and is a most important panic in many parts of the world including the densely populated countries in south Asia. To meet up the rising food demand and varying dietary patterns of rising population, the world needs to make sure sustainable land and water productivity improvements in future[4]. A. G. Condon et al reported that for improved crop production, there is a significant need to get better the water-use efficiency of rain-fed and irrigated areas. The solution is to shift more of the existing water through the crop instead of being wasted as evaporation from the soil surface or drainage ahead of the root zone[5]. Molden et al attempts to raise crop water productivity show most pledge in areas where water productivity is low and those areas often coincide with high incidence of poverty[6]. De Fraiture et al described that rising temperatures, more erratic rainfall patterns and the recent focus on bio fuel production represent major risks for long-term food security and water availability[7]. Hamdy et al found that raising the water-use efficiency of both irrigated and rainfed crop production is an urgent imperative[8]. TC. Rasiuba observed that eighty percent of the agricultural land worldwide is under rain-fed agriculture that is generally low in fertility which resulting in low crop yields[9]. Xi-Ping Deng et al suggested that water scarcity and the abuse of available water resources are the main distress in most developing countries of the Asia. Most countries trying to enhance the limited available water supply by reducing water losses and increasing the water use efficiency and this is the way out to mitigating water shortage and reducing environmental problems[10]. FAO observed that water scarcity affects all social and economic sectors and in most countries, the agriculture sector is suffers from acute water scarcity such as Pakistan, Mexico and large parts of China and India. To maximize the economic and social returns, these countries need to focus on efficient use of the entire water sources and water allocation strategies and also enhance the water productivity of all sectors[11]. A. Raza et al considered that to ensure food security requires a multi disciplinary and an integrated approach that involves raising the efficiency of irrigation system, fertilizer and efficient methods of water application at field level to get better the overall water use efficiency[12]. ESCWA, ICARDA declared that the water use efficiency depends on the technology itself and on the manner to implement it. Pakistan is trying to handle efficiently the demand of the agricultural irrigated activities. The limited water resources are wastefully used and there is lack of consistency in water applications and leaving parts of the field are over-or under-irrigated proportional to crop needs[13]. Dinar documented that water scarcity not only fallout from quantitative or qualitative scarcity, but also from futile use and poor water management[14]. Kijne et al stated that agricultural sector will need of more water to provide additional food, fiber and fuels in the coming dacades[15].

Agriculture in Potwar region is entirely dependent upon rainwater and most of the agriculture is practiced through obsolete irrigation and outmoded cropping methods. As a result, the crops productivity is very low and available water in this water scarce region are not being used properly. Watershed concept is not being followed and upstream and downstream effects are not considered and social aspects ignored. The current project focuses on watershed rehabilitation for enhancing productivity of available water in this region. Keeping in view the circumstances it is extremely enviable to look at the Potwar agriculture from totally a new perspective.

Objectives: i. To characterize irrigated farm resource use around Project site. ii. To assess the water productivity at the selected farms. iii. To develop farmers linkages with the project activities for up scaling High Efficiency Irrigation System (HEIS).

Material and Methods

Description of the study area: Fateh Jang is a town and the tehsil headquarters of Attock District in the Punjab province of Pakistan. It is located nearly 25 miles southwest of Islamabad, on the Rawalpindi-Kohat road. This study was carried out in village Thatti Gujran (Fateh Jang) of Punjab at irrigated farms near the watershed project site. This was contributed to improving water productivity at the farm level, avoiding the loss of water in agriculture and mitigating the effects of water scarcity in the dry areas.

Data collection: The village namely Thatti Gujran was purposively selected because of closest village at the project site. A total of 22 respondents were selected by simple random sampling method and the data were collected both of irrigated and rain-fed areas of the same respondent. The primary data was collected through formal survey using structured questionnaire. Each respondent was interviewed personally and information and data pertaining to all the relevant factors was collected. The respondents were briefed about the objectives of the study. These were facilitating the process of data collection. To achieve the desirable objectives, this study identified the issues that are unique to watersheds like identification of farmers having water resources at their farms.

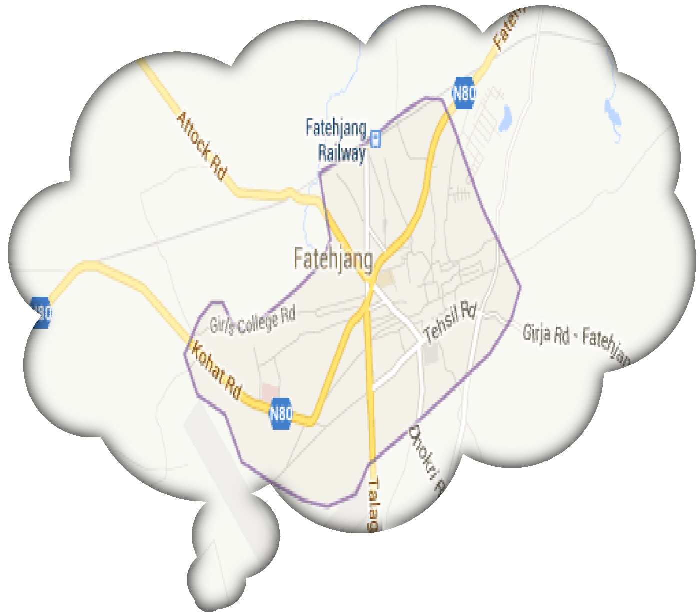

Figure-1
L Map of the Study Area (Fateh Jang)

Data Analysis: The data collected for the present study was analyzed with the help of suitable software. Simple data analysis including frequency distribution, cross tabulation, percentage, and average was performed. Since the present study also examine the water productivity, yield of crops, livestock, input use irrigation technology, water sources, rainfall information and on-farm irrigation practices of respondents. Water productivity is defined as 'crop production per unit amount of water used' (Molden; 1997). So the method of analysis use in this study was valid for water productivity which is given as follows;

$$WP = \text{Yield (Kg)} / \text{Applied water } (m^3) \qquad (1)$$

Variables used in this study were constructed by applying the different formulas followed in different government publications, which was also consistent with the definitions and relevant economic theories. To find out the relationship of selected variables with output, the data were analyzed by using the Ordinary Least Square (OLS) multiple regression technique.

Results and Discussion

This chapter outlines the socio-economic characteristics and interpretation of the data about water productivity in the crops of sampled respondents in tehsil Fatehjang during 2012. The results of the study indicated that extensive water savings will allow farmers to plant more cash crops other than maize and wheat which improving their livelihoods through income generation.

Farm Equipment of Sampled Respondents: Table-1 presented the detail pertaining to the farm equipment of sampled respondents. The figures in the table shows that all the respondents were using tractor for cultivating their fields in which 36 % of the respondents have their own tractors while the remaining 64% were hired the tractors on rent basis. At irrigated farms, dug wells were used by 91% respondents and 9% were used stream as irrigation source in the field. Similarly 82% of the respondent were using water supply scheme provided by government, 14% were using dug wells and 4% were using hand pumps as a source of water for drinking and home consumption

Water Productivity of Wheat: Table-2 presented the water productivity of wheat per hectare at the farmer field. The lowest water productivity was 0.23 kg/m^3 and the highest water productivity was 0.75 kg/m^3 indicating that there were a massive gap which needs to be bridged by sensitizing the farming community through different dissemination techniques like field days and demonstration at the site.

Water Productivity of Sorghum: Table-3 presented and compiling the water productivity of Sorghum. The minimum water productivity was 0.01 kg/m^3 and the highest water productivity was 0.07 kg/m^3. The gap in water productivity between the highest and the lowest productive farmers were 0.06 kg/m^3. Therefore it's indicating that the lowest productive farmers can increase their water productivity levels up to certain levels by keeping other things constant.

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Table-1
Farm Equipment of Sampled Respondents

Sources	Farm Equipments	Frequency	Percent
Farm Traction Power	Tractor	22	100
Ownership of Tractor	Owned	8	36
	Rented	14	64
Irrigation Source at Farm	Dug well	20	91
	Stream	2	9
Irrigation Source at Home	Dug well	3	14
	Bore	1	4
	Water supply	18	82

Survey Results 2012

Table-2
Water Productivity of Wheat (per hectare) (1 inch= 25.4 mm)

No. of Farmers	Irrigation	Depth of Irrigation (mm)	Total Irrigation Depth (mm)	Rain Fall (mm)	Total Water Application (mm)	Yield (kg/ha)	Water Productivity (kg/m^3)
1	6	50.8	304.8	220	524.8	3952	**0.75**
2	12	50.8	609.6	220	829.6	2371.2	**0.29**
3	7	76.2	533.4	220	753.4	4742.4	**0.63**
4	4	50.8	203.2	220	423.2	3161.6	**0.75**
5	6	50.8	304.8	220	524.8	3161.6	**0.60**
6	6	63.5	381	220	601	3161.6	**0.53**
7	6	50.8	304.8	220	524.8	1185.6	**0.23**
8	6	76.2	457.2	220	677.2	2371.2	**0.35**
9	10	76.2	762	220	982	3161.6	**0.32**
10	8	50.8	406.4	220	626.4	1580.8	**0.25**
11	6	76.2	457.2	220	677.2	2371.2	**0.35**
12	7	50.8	355.6	220	575.6	2371.2	**0.41**
13	5	50.8	254	220	474	2371.2	**0.50**
14	7	76.2	533.4	220	753.4	3161.6	**0.42**
15	6	50.8	304.8	220	524.8	3161.6	**0.60**
16	7	50.8	355.6	220	575.6	3161.6	**0.55**
17	10	76.2	762	220	982	2371.2	**0.24**
18	8	50.8	406.4	220	626.4	3161.6	**0.50**
Total	**127**	**1079.5**	**7696.2**	**3960**	**11656.2**	**50980.8**	**8.27**

Survey Results 2012

Table-3
Water Productivity of Sorghum (per hectare)

No. of Farmers	Irrigation	Depth of Irrigation (mm)	Total Irrigation Depth (mm)	Rain Fall (mm)	Total Water Application (mm)	Yield (kg/ha)	Water Productivity (kg/m^3)
1	8	50.8	406.4	220	626.4	237.12	**0.04**
2	12	76.2	914.4	220	1134.4	158.08	**0.01**
3	10	25.4	254	220	474	316.16	**0.07**
4	9	76.2	685.8	220	905.8	395.2	**0.04**
5	10	50.8	508	220	728	237.12	**0.03**
6	12	76.2	914.4	220	1134.4	316.16	**0.03**
Total	**61**	**355.6**	**3683**	**1320**	**5003**	**1659.84**	**0.22**

Survey Results 2012

Table-4
Water Productivity of Maize (per hectare)

No. of Farmers	Irrigation	Depth of Irrigation (mm)	Total Irrigation Depth (mm)	Rain Fall (mm)	Total Water Application (mm)	Yield (kg/ha)	Water Productivity (kg/m^3)
1	10	76.2	762	220	982	2371.2	**0.24**
2	12	50.8	609.6	220	829.6	1580.8	**0.19**
3	10	76.2	762	220	982	2371.2	**0.24**
4	5	50.8	254	220	474	1580.8	**0.33**
5	5	50.8	254	220	474	2371.2	**0.50**
6	7	101.6	711.2	220	931.2	1580.8	**0.17**
7	5	50.8	254	220	474	1185.6	**0.25**
8	5	63.5	317.5	220	537.5	1580.8	**0.29**
9	8	88.9	711.2	220	931.2	2371.2	**0.25**
10	4	50.8	203.2	220	423.2	1580.8	**0.37**
11	5	50.8	254	220	474	2371.2	**0.50**
12	5	50.8	254	220	474	1580.8	**0.33**
13	6	76.2	457.2	220	677.2	2766.4	**0.41**
14	7	50.8	355.6	220	575.6	1580.8	**0.27**
15	5	50.8	254	220	474	1580.8	**0.33**
16	5	76.2	381	220	601	2371.2	**0.39**
17	8	63.5	508	220	728	1580.8	**0.22**
18	5	76.2	381	220	601	1580.8	**0.26**
Total	**117**	**1155.7**	**7683.5**	**3960**	**11643.5**	**33987.2**	**5.57**

Survey Results 2012

Water Productivity of Maize: Table-4 depicts the water productivity of maize. The minimum water productivity of maize was 0.17 kg/m^3 and the maximum water productivity was 0.50 kg/m^3. The gap in water productivity is 0.33 kg/m^3. Hence it is indicated that farmers can increase their water productivity up to the level of 0.33 kg/m^3 without compromising on the maize yield.

Water Productivity of Turnip: Table-5 presented the water productivity of turnip. In case of turnip the minimum water productivity was 0.83 kg/m^3 and the maximum water productivity was 3.26 kg/m^3. The difference in water productivity was 2.43 kg/m^3. The gap in water productivity indicates that the lowest productive farmers can produce the same amount of turnip even by lowering the water productivity.

Water Productivity of Radish: Table-6 presented the water productivity of radish. The minimum water productivity of radish was 0.78 kg/m^3 and the maximum water productivity was 3.26 kg/m^3. The gap in water productivity was 2.48 kg/m^3. This enormous gap in water productivity indicates that the lowest productive farmers can increase their levels of water productivity up to certain levels without compromising on the radish yield.

Water Productivity of Methi: Table-7 presented the water productivity of methi. The minimum water productivity was 0.28 kg/m^3 and the highest water productivity was 0.41 kg/m^3. The difference in water productivity was 0.13 kg/m^3. The difference in the lowest and the highest water productivity indicates that the lowest productive farmers can increase their productivity levels up to certain levels without decreasing the productivity.

Comparative Analysis of the Water Productivity of Selected Crops: Table-8 presented the water productivity of the selected crops. The mean water productivity of wheat, sorghum, maize, turnip, radish and methi were 0.46, 0.22, 0.31, 1.91, 1.88 and 0.34 kg/m^3 respectively. The comparative analysis of the water productivity indicates that sorghum has the lowest water productivity followed by the maize and methi while turnip has the highest water productivity followed by the radish and wheat. The mean water productivity of turnip was 1.91 kg/m^3 indicates that from one cubic meter of water 1.91 kg of turnip can be produced. Similarly the mean water productivity of wheat 0.46 kg/m^3 indicates that from one cubic meter of water 0.46 kg of wheat can be produced.

Table-5
Water Productivity of Turnip (per hectare)

No. of Farmers	Irrigation	Depth of Irrigation (mm)	Total Irrigation Depth (mm)	Rain Fall (mm)	Total Water Application (mm)	Yield (kg/ha)	Water Productivity (kg/m^3)
1	17	76.2	1295.4	220	1515.4	12646.4	**0.83**
2	7	76.2	533.4	220	753.4	11065.6	**1.47**
3	12	50.8	609.6	220	829.6	11856	**1.43**
4	15	76.2	1143	220	1363	27664	**2.03**
5	8	76.2	609.6	220	829.6	23712	**2.86**
6	18	50.8	914.4	220	1134.4	19760	**1.74**
7	16	50.8	812.8	220	1032.8	17388.8	**1.68**
8	8	63.5	508	220	728	23712	**3.26**
Total	**101**	**520.7**	**6426.2**	**1760**	**8186.2**	**147804.8**	**15.30**

Survey Results 2012

Table-6
Water Productivity of Radish (per hectare)

No. of Farmers	Irrigation	Depth of Irrigation (mm)	Total Irrigation Depth (mm)	Rain Fall (mm)	Total Water Application (mm)	Yield (kg/ha)	Water Productivity (kg/m^3)
1	17	76.2	1295.4	220	1515.4	11856	**0.78**
2	13	50.8	660.4	220	880.4	23712	**2.69**
3	18	50.8	914.4	220	1134.4	17388.8	**1.53**
4	15	50.8	762	220	982	15808	**1.61**
5	12	76.2	914.4	220	1134.4	9484.8	**0.84**
6	7	76.2	533.4	220	753.4	11065.6	**1.47**
7	13	50.8	660.4	220	880.4	23712	**2.69**
8	12	50.8	609.6	220	829.6	11856	**1.43**
9	15	76.2	1143	220	1363	27664	**2.03**
10	8	63.5	508	220	728	19760	**2.71**
11	13	50.8	660.4	220	880.4	19760	**2.24**
12	15	76.2	1143	220	1363	19760	**1.45**
13	13	50.8	660.4	220	880.4	23712	**2.69**
14	20	50.8	1016	220	1236	17388.8	**1.41**
15	18	50.8	914.4	220	1134.4	13436.8	**1.18**
16	16	50.8	812.8	220	1032.8	19760	**1.91**
17	8	63.5	508	220	728	23712	**3.26**
Total	**233**	**1016**	**13716**	**3740**	**17456**	**309836.8**	**31.94**

Survey Results 2012

Table-7
Water Productivity of Methi (per hectare)

No. of Farmers	Irrigation	Depth of Irrigation (mm)	Total Irrigation Depth (mm)	Rain Fall (mm)	Total Water Application (mm)	Yield (kg/ha)	Water Productivity (kg/m^3)
1	19	50.8	965.2	220	1185.2	3952	**0.33**
2	12	76.2	914.4	220	1134.4	3161.6	**0.28**
3	10	50.8	508	220	728	2964	**0.41**
Total	**41**	**177.8**	**2387.6**	**660**	**3047.6**	**10077.6**	**1.02**

Survey Results 2012

Table-8
Comparative Analysis of Water Productivity of Selected Crops (Mean)

Crops	Irrigation	Depth of Irrigation (mm)	Total Irrigation Depth (mm)	Rain Fall (mm)	Total Water Application (mm)	Yield (kg/ha)	Water Production (kg/m^3)
Wheat	7.05	59.97	427.56	220	647.56	2832	**0.46**
Sorghum	10.16	59.26	613.83	220	833.83	277	**0.22**
Maize	6.50	64.20	426.86	220	646.86	1888	**0.31**
Turnip	12.62	65.08	803.27	220	1023.27	18476	**1.91**
Radish	13.70	59.76	806.82	220	1026.82	18226	**1.88**
Methi	**13.66**	**59.266**	**795.866**	**220**	**1015.86**	**3359**	**0.34**

Survey Results 2012

Conclusion

All scenario results confirm the fact that there is an imperative need of proper sustainability and efficient use of available water resources to meet the present and future requirements and socio-economic objectives of the country. Thus, it is suggested that water productivity at the fields of farmers are low and this was due to over irrigation and no proper idea of exact irrigation timing and knowledge about high efficiency irrigation system. In order to maximize the water productivity there is severe need of proper use of available water through high efficiency irrigation technologies and should create new resources like small dams and ponds to save the surface water for unforgiving condition in the study area. A very small numbers of farmers have used water for agriculture purposes due to water shortage. The dug wells in the study area were very old and majority of farmers pull the water on traditional way. Some of farmers were using electric motors but due to electricity problem they suffered a lot. This paper emphasizes on how to optimally allocate the limited available water to meet up the socio-economic objectives.

Recommendations: i. It will be better to select most suitable and cash crops for the region according to water quantity available, avoid excessive cultivation with optimal tillage and apply manure and fertilizer effectively. ii. To prevent water deficits, taking account of weather conditions and irrigate the field at high frequency and in the exact amounts needed. iii. The Government should be solved the electricity problems and should fund technical and planning assistance because farmers would benefit from them to evaluate and recommend technologies for their particular situations. iv. Rainwater harvesting allows maximum use of rainfall through ponds, tanks and small dams which can be used for irrigation during dry season. v. partnerships should be build up with government educational and research institutions to provide educational, informational, and training opportunities to growers and water supplier staff. iv. Carries out data analysis of demonstration projects and research to achieve maximum water productivity.

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